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19EC10088

1.i)
$\Delta_1 = 88 \bmod 20 = 8$

$I_S = \left(5 + \frac{\Delta 1}{10}\right) \times 10^{-16} A$

$= 5.8 \times 10^{-13}$ mA

$\beta = 100 + 8 = 108$

$V_A = \infty$

$V_T = 26$ mV

$V_{DD} = 5 + \frac{\Delta 1}{10} = 5.8$ V

a) $V_{BE} = 0.7V$

$I_C = I_S \exp\left(\frac{V_{BE}}{V_T}\right) = 5.8 \times 10^{-13} \exp\left(\frac{0.7}{0.026}\right)$

$= 0.2857$ mA

$g_m = \frac{I_C}{V_T} = \frac{0.2857 \text{ mA}}{0.026 \text{ V}} = 10.99 \, (k\Omega)^{-1}$

$\approx 11 \, k\Omega^{-1}$ (Ans)

b) $V_{R_C} = \frac{V_{DD}}{2} = 2.9V$

$I_C = 0.2857$ mA

$R_C = 10.15 \, k\Omega$ (Ans)

c) $V_{RE} \sim 0.1 \sim 0.3 V_{CC}$

$\therefore$ voltage drop across R_E for bias stability

~~= 0.29 V~~

= 0.58 V approx or 0.5V approx

bias currents must be negligible to reduce loss through biasing of power.

d) If bias current is negligible

$\frac{V_{dd}}{R_1 + R_2} \gg I_B \qquad I_B = \frac{I_C}{\beta} = 2.64 \times 10^{-3}$ mA

or $\frac{V_{dd}}{R_1 + R_2} = 10 I_B$

or $\frac{V_{dd}}{R_1 + R_2} = 26.4 \times 10^{-3}$

or $R_1 + R_2 = 219.25 \, k\Omega$

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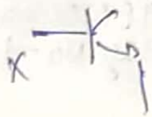

$V_{RE} = 0.5\,V$
$V_{BE} = 0.7\,V$
$\therefore V_X = 1.2\,V$

$V_{RE} = 0.5\,V$
$I_E = 0.2857\,mA$
$R_E = 1.45\,k\Omega$

$V_X = (10 I_B) R_2$

or $R_2 = \dfrac{1.2}{10 \times 2.64 \times 10^{-3}}$

or $R_2 = \dfrac{500}{11} = 45.45\,k\Omega$ (Ans)

$R_1 = 219.25 - 45.45 = 173.79\,k\Omega$ (Ans)

$\dfrac{V_X}{R_2} = 10 I_B$ implies bias current is less than current through R_2

e) $A_V = -\dfrac{R_C}{\frac{1}{g_m}} = -g_m R_C$

$= -10.99 \times 10.15$

$= -111.54$

f) Since there are 3 capacitors we expect 3 poles one associated with each node.

g) $|\omega_{p1}| = \dfrac{1}{C_{c1}(R_1 \| R_2)} = 5.9\ rad\,s^{-1}$

$|\omega_{p2}| = \dfrac{1}{R_E C_E} = \dfrac{1}{1.75 \times 47 \times 10^{-6} \times 10^{3}} = 121.57\ rad\,s^{-1}$

$|\omega_{p3}| = \dfrac{1}{C_{c2}(R_C)} = 20.96\ rad\,s^{-1}$